Forest Health Protection

Pacific Southwest Region
Northeastern California Shared Service Area

Date: October 3, 2023

To: District Ranger, American River Ranger District, Tahoe National Forest

Subject: Stand conditions within the Shirttail Project (FHP Report NE23-02)

Background

At the request of Kelly Pavlica, District Silviculturist, American River Ranger District, Danny Cluck, Forest Health Protection (FHP) Entomologist, conducted a field evaluation of the Shirttail Project on June 8, 2023. The objective of this visit was to evaluate existing stand conditions and document current insect and disease activity. Recommendations provided in this report will assist in the formulation of silvicultural prescriptions that reduce stand density, reduce ladder fuels, and provide for a more drought, bark beetle and fire resilient species composition.

Key Findings

- Many stands, including some previously thinned stands, are in an overstocked condition that increases their susceptibility to bark beetle attack.
- Past thinning treatments in ponderosa pine plantations used residual stocking levels that were based on accepted bark beetle susceptibility thresholds that now are insufficient during the recent extreme drought conditions and western pine beetle outbreak.
- The ongoing western pine beetle outbreak appears to have declined in intensity from the prior two years, but elevated ponderosa pine mortality continues (Figure 1).
- Thinning to reduce stand density and increase heterogeneity is highly recommended throughout older plantations and native stands, including within some previously thinned stands.

Figure 1. Ponderosa pine mortality and top kill caused by western pine beetle and California fivespined ips bark beetles, Shirttail project, 2022.

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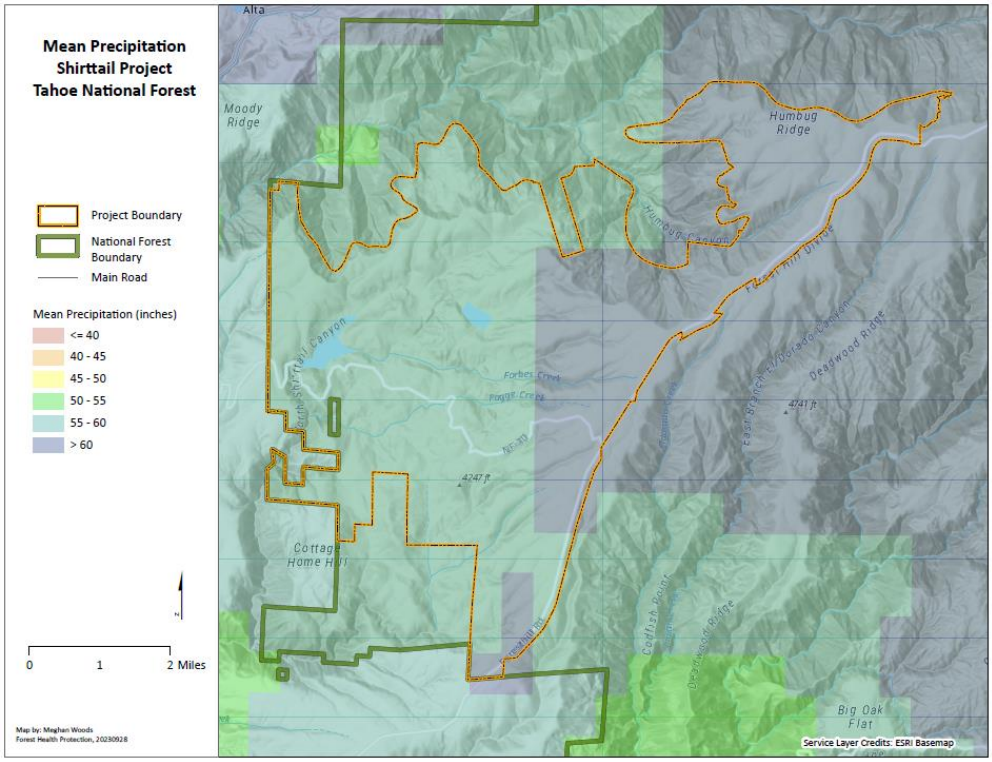
Description of the project area

The Shirttail Project area, which includes portions of the Volcano Plantation (established in early 1960s) and Elliot Ranch Plantation (established in early 1950s) is located about 11 miles NE of Foresthill, CA at elevations ranging between 3800 and 4500 feet (approx. 39° 09' 12.4"N and 120° 45' 22.6"W). Annual precipitation is approximately 50 - 60 inches (Figure 2). Plantation stands are predominantly ponderosa pine (*Pinus ponderosa*) with other species such as white fir (*Abies concolor*), incense cedar (*Calocedrus decurrens*), sugar pine (*Pinus lambertiana*) and Douglas-fir (*Psuedotsuga menziesii*) that have seeded in naturally from adjacent stands. Most trees have reached an average DBH of ~18", ranging from approximately 10" to 28" dbh. Thinning treatments over the past 20 years have raised the average DBH to greater than 24" in many locations. Native stands are mature Sierran mixed conifer with a black oak (*Quercus kelloggii*) component.

Figure 2. Mean annual precipitation for the Shirttail Project and surrounding area.



Forest insect and disease conditions

Western pine beetle (*Dendroctonus brevicomis*) activity appears to be declining from outbreak levels observed in 2021 and 2022, thanks in part to an above average winter, but tree mortality remains elevated throughout the project area. Several locations have had most, or all ponderosa pine killed over the past 3 years in addition to mortality experienced in the 2015 and 2016 outbreak years (Figure 3). Reduction of susceptible hosts in some areas may also be a factor in the observed outbreak decline.

Unthinned, pine dominated stands have experienced most of the mortality during recent western pine beetle outbreaks. These include riparian habitat zones and wildlife areas that were avoided during previous projects to retain high canopy cover. Stands thinned to 80 – 120 ft^2/acre of basal area in 2010 have experienced the second most western pine beetle activity and associated mortality, especially when follow-up prescribed fire resulted in significant injury to tree crowns and boles. These previously thinned stands have put on significant growth since treatment with some areas reaching more than 180 ft^2/acre BA. Minimal mortality has occurred in stands that were thinned to 80 ft^2/acre on average. In addition to a lower residual basal area target, these treatments also removed most pine from around residual oaks, further reducing stand density and creating heterogeneity. This treatment is holding up well both in prescribed burned and unburned areas.

Dense ponderosa pine pockets in mixed conifer stands are also experiencing elevated mortality but mixed conifer stands in general are doing well with only fir engraver beetle (*Scolytus ventralis*) in white fir causing elevated mortality. This fir mortality is also associated with Heterobasidion root disease (*Heterobasidion occidentale*) in some locations. All other tree species are experiencing few, if any, pest problems.

Stand conditions and mortality related to recent and future climate trends

Many stands within the Shirttail project area are extremely dense, based on relative stand density (rSDI) values, and have exhibited elevated levels of tree mortality caused by bark beetles, especially during recent periods of drought (Table 1, Figures 4 and 5). This mortality combined with high stand density has resulted in heavy fuel loading in many areas and a corresponding increase in potential fire behavior.

Figure 3. Ponderosa pine mortality caused by western pine beetle, Shirttail Project, 2022.

Predicted climate change is likely to impact trees growing in the Shirttail project area over the next 100 years. Although no Tahoe National Forest specific climate change models are available at this time, there is a consensus among California models that summers will be drier than they are currently. This prediction is based on the forecasted rise in mean minimum and maximum temperatures and remains consistent regardless of future levels of annual precipitation (B. Estes and S. Gross, *Tahoe National Forest Climate Change Trend Summary*, 2020). The risk of bark beetle-caused tree mortality will increase for all conifer species under this scenario, especially overstocked monoculture ponderosa pine plantations and drought intolerant and root diseased white fir. Improving the resilience of the Shirttail project area to future disturbance events through density, size class and species composition management will be critical to maintaining a healthy forested landscape.

Table 1. Acres with mortality, estimated dead trees per acre and estimated total # of dead trees from R5 Aerial Detection Surveys and Palmer Hydrologic Drought Index (PHDI) (average of CA Divisions 2 and 3[1]) by water year (Oct-Sept) within the Shirttail Project area. No survey in 2020. 2023 acres and # dead tree values not available for this report. Preliminary mortality polygons show additional tree mortality in 2023.

Year	Acres	Dead Trees/Acre	Total # of Dead Trees	PHDI[2]
2022	4,944	17.9	88,429	-3.04
2021	1,844	25.2	46,463	-4.23
2020	No survey	No survey	No survey	-1.45
2019	699	5.7	3,989	0.99
2018	1,022	3.4	3,492	-0.83
2017	693	16.9	11,701	3.03
2016	5,717	5.3	30,216	-1.32
2015	454	4.2	1,923	-3.34
2014	312	8.8	2,733	-3.56
2013	567	2.2	1,239	-2.16
2012	409	1.2	491	-3.04

[1] California Divisions 2 and 3 encompass most of northeastern California.
[2] PHDI values ranging from -2.00 to -2.99 are considered moderate drought conditions. Severe drought conditions range from -3.00 to -3.99 and extreme drought conditions are below -4.00.

Figure 4. Number of dead trees per acre from 2013 to 2022 in the Shirttail Project area. No survey in 2020 and 2023 trees/acre data not available. There are more dead trees/acre than depicted on this map (see Fig. 5).

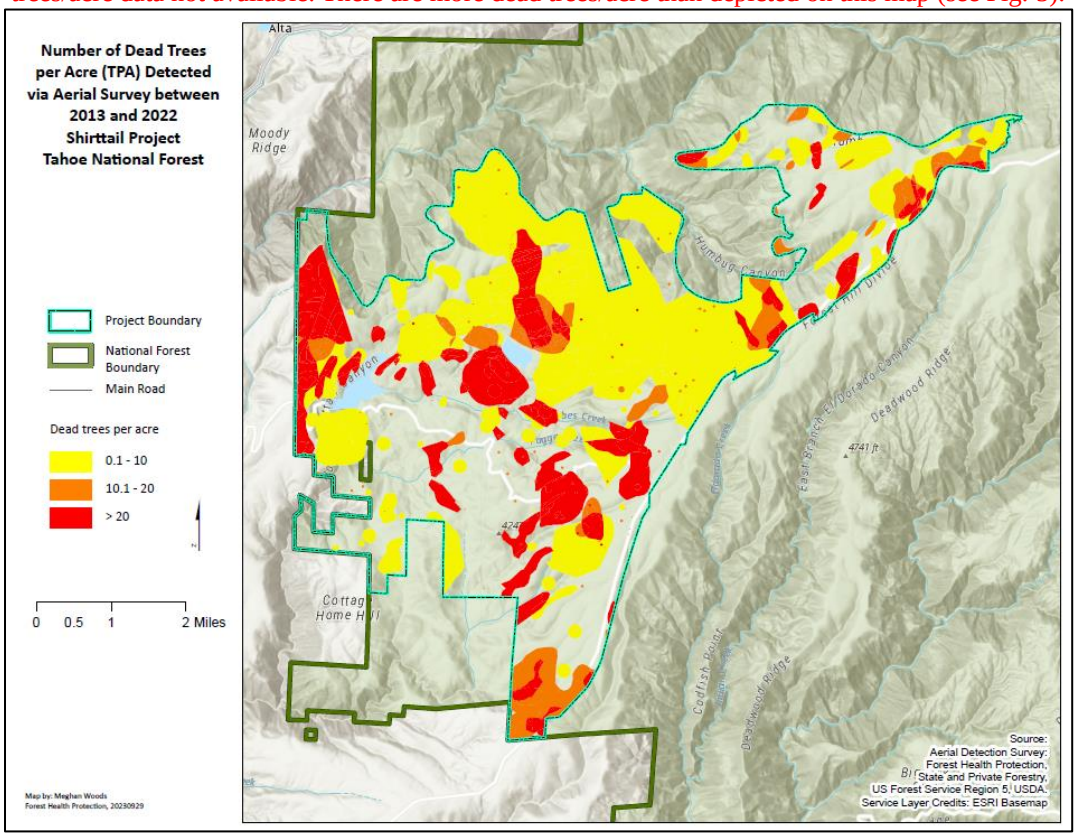
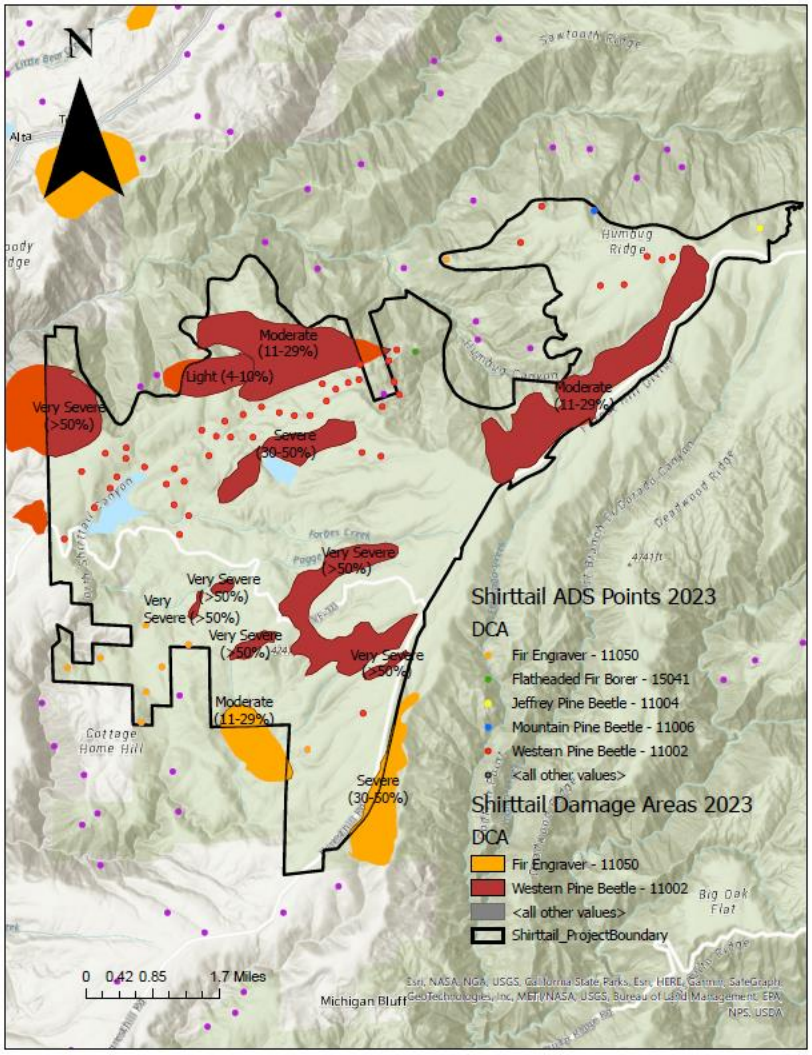


Figure 5. Areas of mapped tree mortality and severity within and adjacent to the Shirttail Project area, 2023.



Discussion and recommendations

Long-term management

The best strategy to decrease the amount of additional mortality is to reduce stand density through thinning in untreated stands and, depending on existing stocking and species composition, to further reduce density in previously treated stands. Thinning will increase the health and vigor of residual trees by reducing competition for limited soil moisture (Fettig et al. 2007). Mechanical thinning is recommended for the initial treatment to reduce stand density and ladder fuels that will allow long-term maintenance with prescribed fire without causing excessive mortality of residual trees.

Thinning to a relative density of 25 - 40% (relative to the maximum Stand Density Index, or SDI) will effectively reduce competition for limited water and nutrients and reduce the susceptibility to future bark beetle-caused tree mortality for many years. The District should consider using the bark beetle limiting SDI of 365 (Oliver 1995, Zhang et al., 2013 and 2019) as the SDImax for

ponderosa pine plantations and SDImax of 450 (Long and Shaw 2005) for pine dominated mixed conifer on drier sites. An SDImax of 550 (Long and Shaw 2012) should be considered in more mesic Sierran mixed conifer, such as north facing slopes and drainages. In any mixed conifer stand, larger pockets of pure ponderosa pine should be thinned to pine stocking targets to minimize potential bark beetle-caused mortality and further create heterogenous densities within stands.

Residual stand density targets in terms of basal area were discussed during this site visit that align with the above SDI considerations. These residual basal area levels were based on the observed success and failure of past treatments in the area, especially for the ponderosa pine plantations. For ponderosa pine, 60-80 ft^2/ac may be sufficient to reduce the risk of bark beetle-caused mortality. The lower end of this stocking range should be emphasized to increase treatment longevity with the addition of further reduction of pine stocking where alternative species exist (such as mature black oak and young incense cedar and Douglas-fir that have established within pine plantations) to increase heterogeneity. For mixed conifer, thinning drier sites down to a range of 80-120 ft^2/ac and wetter sites down to 120-150 ft^2/ac should increase health and vigor of residual trees. Again, emphasizing the lower end of these ranges will increase the longevity of treatments.

This level of stand density reduction is supported by the latest research showing that Sierra Nevada mixed conifer stands seldom, if ever, exceeded rSDI of 60% (zone of imminent mortality) and most often maintained densities below the onset of competition (rSDI of 25%) (North et al 2022). In addition, recent analysis of several bark beetle outbreaks in yellow pine dominated forests suggest much lower stocking levels are needed to minimize bark beetle activity. Specifically, their analysis indicated that the resistance levels suggested in earlier studies at 200 SDI (55% of the bark beetle limiting SDI of 365) were insufficient to provide for either a high-level, or moderate level, of resistance when challenged by severe beetle pressure levels. Overall, results indicated substantially lower stand density levels <100 SDI (27% of bark beetle limiting SDI) are needed to promote high-level resistance, and <150 SDI (41% of bark beetle limiting SDI) to promote moderate-level resistance, to severe *Dendroctonus* spp. population pressure that has been documented during primarily dry time segments from 2000-2018 (Fettig et al 2021). These resistance thresholds for low, moderate, and high protection against mortality during outbreaks, in terms of tree diameter and spacing, are listed in Appendix B. Incorporating these different stocking levels into a heterogeneous treatment of existing ponderosa pine stands should provide a higher level of protection from drought and bark beetles while allowing for successful reintroduction of low intensity prescribed fire.

When planning thinning treatments, it should be recognized that the target stand density and species composition is an average to be applied across the landscape and some variability may be desired. Individual high-value trees, such as mature pines, and drier areas dominated by ponderosa pine should benefit by having the stocking reduced to lower levels. Allowing for denser tree spacing and pockets of higher canopy cover may be desirable around potential wildlife trees, such as forked and/or broken-topped trees.

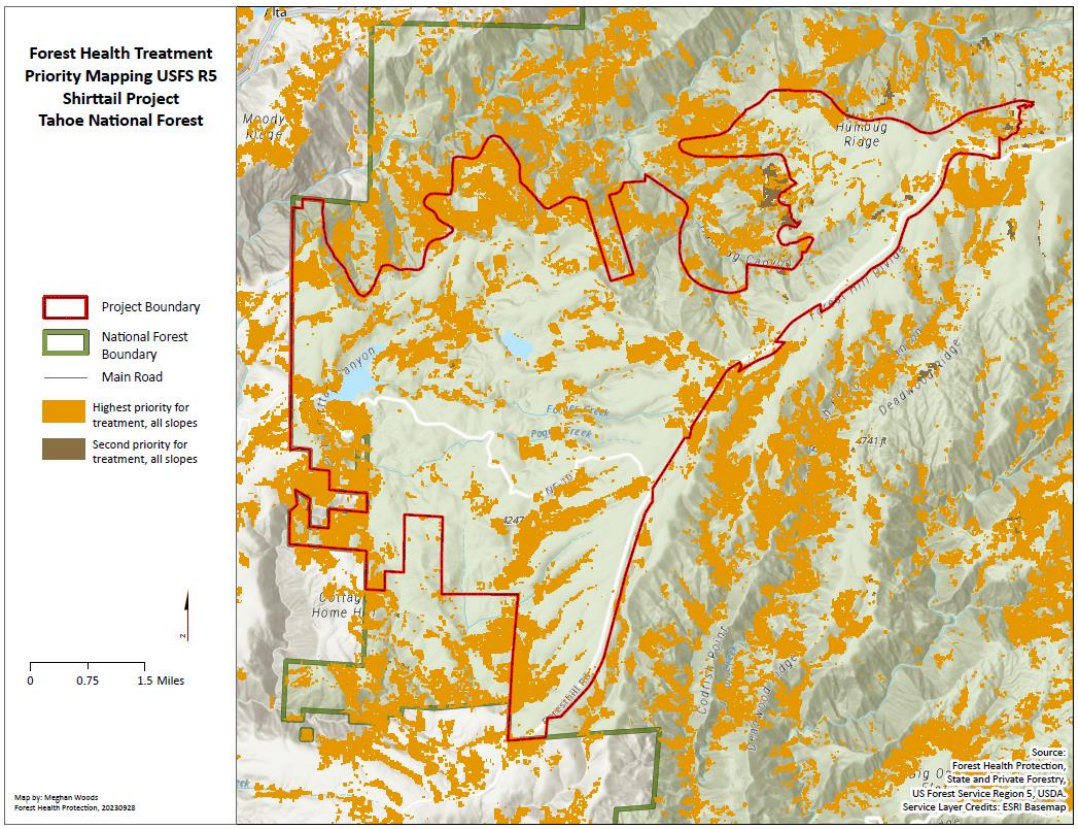
It is recommended that a registered borate compound be applied to all freshly cut pine stumps >14” in diameter to reduce the chance of creating new infection centers of *Heterobasidion irregulare* if there are known or suspected root disease pockets with 1/3 mile of treatment units or if distance to HRD is unknown. Treatment of white fir stumps is a low priority unless a treatment

unit contains mostly healthy, and presumably disease free, trees. Stumps created along roadways and infrastructure are a higher priority for treatment regardless of species. Please refer to the new borate treatment recommendation table (Appendix C).

Forest Health Protection developed a treatment priority map for Region 5 to help land managers prioritize thinning treatments at the landscape level. This map depicts forested areas on National Forest System lands that are the most susceptible to drought and bark beetle-caused tree mortality based on forest type and stand density. Mapped areas must meet the criteria of not having burned at moderate to high severity since 1998 and not having been thinned since 2005. In addition to being overly dense, most of these areas have a history of tree mortality during drought resulting in heavy fuel loads and higher risk of stand replacing wildfire. Highest priority areas consist of high-density pine stands, pine-dominated mixed conifer stands, and fir-dominated mixed conifer and white fir stands growing on historically pine dominated sites. Second priority areas consist of high-density fir-dominated mixed conifer and white fir stand on wetter sites. All mapped stands are California Wildlife Habitat Relationship size class 4, 5 and 6.

Figure 6 shows treatment priority areas on all slopes within the Shirttail project area. This mapping effort utilized remotely sensed data to create treatment priority layers for large scale planning and may not be accurate at the stand level. This map of the Shirttail project area does not illustrate the all the areas in need of treatment. Treated stands (stands thinned since 2005) were removed

Figure 6. Treatment Priority Areas at risk to bark beetle-caused mortality within the Shirttail Project area



from this map once they were entered into FACTS. This includes stands that were thinned within the past 15 years to densities that are not holding up to bark beetle pressure under current drought conditions. It also includes previously thinned stands that have now grown back into an overstocked condition and are once again susceptible to bark beetle attack. The forest should still use stand records, stand exam data and local knowledge to identify treatment areas and develop silvicultural prescriptions.

Short-term management

The current western pine beetle outbreak continues to threaten ponderosa pines within the Shirttail project area with many more trees expected to be attacked and killed before preventative thinning treatments can be implemented. This is a major concern for recreation areas and campgrounds, such as those at Sugar Pine Reservoir, where loss of pines results in an increase in hazard trees and a loss of canopy cover for campsite and day-use shade. To immediately protect individual trees in the short-term there is basically one established option, application of preventative insecticides to the bole. Selected high value trees in the campgrounds can be treated with a registered pesticide by spraying the bole to the point of saturation to a height of ~35 to 50ft depending on tree diameter. There are two types of insecticides registered for use against bark beetles in California, carbaryl, or the pyrethroids bifenthrin or permethrin. If applied properly, carbaryl treatments provide two years of protection for most pine species; pyrethroid treatments provide one year of protection. Forest Health Protection and the American River RD successfully sprayed a limited number of trees with carbaryl in 2022 in Giant Gap and Shirttail campgrounds. Retreatment of these trees and treatment of additional trees is recommended if western pine beetle activity continues over the next several years.

Potential for funding through the Western Bark Beetle Program

Forest Health Protection may be able to assist with funding, including NEPA activities, for thinning within the Shirttail Project area. Thinning treatments that reduce stand density and change species compositions sufficient to lower the risk to bark beetle-caused mortality would meet the minimum requirements for Western Bark Beetle Program funding and would be supported by this evaluation. If you are interested in this funding please contact me for assistance in adding project to R5 Capability Request spreadsheet.

If you have any questions regarding this report and/or need additional information please contact Danny Cluck at 530-708-2770.

/s/ Danny Cluck

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Appendix A: Stand density table

Tree-Level SDI Thresholds and Spacing Equivalence to Promote Bark Beetle Resistance within Ponderosa Pines

Note: Spacing Targets Should be Adjusted to Account for Post-Treatment Vegetation Growth throughout the Time Horizon that Resistance is Needed

Based on Meta-Analysis of data from 662 plots covering >60,000 trees 'challenged' by Dendroctonus spp. populations

Tree Diameter	**Minimum Protection: 200 SDI** Assuming a Severe *Dendroctonus* spp. Outbreak: *48% probability of High-Degree Resistance (>90% pine survival)* *69% probability of Moderate-Degree Resistance (>70% pine survival)*			**Moderate Protection: 150 SDI** Assuming a Severe *Dendroctonus* spp. Outbreak: *64% probability of High-Degree Resistance (>90% pine survival)* *84% probability of Moderate-Degree Resistance (>70% pine survival)*			**High Protection: 100 SDI** Assuming a Severe *Dendroctonus* spp. Outbreak: *85% probability of High-Degree Resistance (>90% pine survival)* *95% probability of Moderate-Degree Resistance (>70% pine survival)*			Tree Diameter
(inches)	Trees/acre	Spacing	BA/acre	Trees/acre	Spacing	BA/acre	Trees/acre	Spacing	BA/acre	(inches)
4	870	7	76	653	8	57	479	10	42	4
5	608	8	83	456	10	62	335	11	46	5
6	454	10	89	341	11	67	250	13	49	6
7	355	11	95	266	13	71	195	15	52	7
8	286	12	100	215	14	75	157	17	55	8
9	237	14	105	178	16	78	130	18	58	9
10	200	15	109	150	17	82	110	20	60	10
11	172	16	113	129	18	85	94	21	62	11
12	149	17	117	112	20	88	82	23	64	12
13	131	18	121	98	21	91	72	25	67	13
14	117	19	125	87	22	93	64	26	69	14
15	104	20	128	78	24	96	57	28	70	15
16	94	22	131	71	25	98	52	29	72	16
17	85	23	135	64	26	101	47	30	74	17
18	78	24	138	58	27	103	43	32	76	18
19	71	25	141	54	29	105	39	33	77	19
20	66	26	143	49	30	108	36	35	79	20
21	61	27	146	46	31	110	33	36	80	21
22	56	28	149	42	32	112	31	37	82	22
23	53	29	152	39	33	114	29	39	83	23
24	49	30	154	37	34	116	27	40	85	24
25	46	31	157	34	36	117	25	42	86	25
26	43	32	159	32	37	119	24	43	88	26
27	41	33	161	30	38	121	22	44	89	27
28	38	34	164	29	39	123	21	45	90	28
29	36	35	166	27	40	125	20	47	91	29
30	34	36	168	26	41	126	19	48	93	30
31	33	37	171	24	42	128	18	49	94	31
32	31	38	173	23	43	130	17	51	95	32
33	29	38	175	22	44	131	16	52	96	33
34	28	39	177	21	45	133	15	53	97	34
35	27	40	179	20	47	134	15	54	98	35

Contact Joel Egan, FHP Group Leader, joel.egan@usda.gov, 406-329-3278 for details on using this chart

Table provides the trees/acre, spacing, and basal area equivalence across constant 200, 150, or 100 SDI levels, respectively

Appendix B. Borate stump treatment recommendations to prevent Heterobasidion root disease

Priorities for stump borate treatments to prevent Heterobasidion Root Disease (HRD) v.4.5
Contact your Forest Health Protection Entomologist or Plant Pathologist for assistance

USFS Region 5 - BORATE STUMP TREATMENT PRIORITY BY FOREST CONDITION and HARVEST ACTIVITY			
Priority	**HARVEST ACTIVITY in FOREST TYPE and CONDITION**	***TREAT WHICH STUMPS?**	**WHY**
Very Low	Salvage high severity burn (nearly all trees killed); plant	NONE	Little connectivity with seedling roots; Most dead roots get infected with competing organisms before seedling roots contact them
Very Low	Clearcut PP/JP, true fir or mixed conifer; any location including roadsides and powerline corridors	NONE	Very low probability of new establishing new infection centers
Very Low	Thin true fir which has widespread light to heavy HRD	NONE	Borates do not cure existing infection
Low	Thin PP/JP with no current or historic pine HRD within 1700 feet	NONE	Very low atmospheric spore concentration
Low	Thin PP/JP in mixed species stands; few >14" PP/JP stumps	NONE	Small pine stumps don't create HRD centers; small roots get infected fast with competing organisms
Low	Thin PP/JP in mixed species stands; few pine-to-pine root contacts	NONE	HRD won't spread from stumps that don't have root contact w/ live trees
Low	Thin Doug-fir; incense cedar; sugar pine; other conifers	NONE	Little evidence of HRD problems
Moderate	Salvage low to moderate severity burn (scattered remaining green trees)*	Consider treating >14" PP/JP and > 24" juniper stumps having possible root contact with high-value PP/JP. Treat true fir stumps in stands with no fir HRD	Borates do not cure existing infections. Treating pine stumps near high-value pine trees can protect residual pine from HRD. Large juniper stumps may facilitate spread to adjacent pines.
High	Any cutting, PP/JP, true fir in roadside and powerline corridors (including hazard tree removal and salvage* in low to moderate severity burns)	Treat all PP/JP and > 24" juniper stumps and true fir stumps >14"	Borates prevent infection; lower tolerance for new HRD centers in these areas. Large juniper stumps may facilitate spread to adjacent pines.
High	Thin PP/JP in mixed species stands; many >14" PP/JP stumps and pine-to-pine root contacts; pine HRD within 1700 feet (or distance to nearest HRD not known)	>14" PP/JP stumps (also >24" juniper stumps if present)	Borates prevent infection. Large juniper stumps may facilitate spread to adjacent pines.
High	Thin true fir with no HRD	> 14" fir stumps	Borates prevent infection
Very High	Thin PP/JP; many >14" stumps; pine HRD within 1700 feet (or distance to nearest HRD not known)	>14" PP/JP stumps	Every stump can start HRD centers
Very High	Recreation and Administrative Sites	>3" conifer stumps	Zero tolerance for new HRD centers in these areas means treating smaller stumps of all conifer species
Very High	Thin giant Sequoia groves; treat conifer stumps within 1700 feet of monarch giant sequoia trees	>3" conifer stumps	Zero tolerance for new HRD centers in these areas means treating smaller stumps of all conifer species

* No need to treat stumps of trees with no needles or stumps of trees killed by fire >18 months earlier